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(54) IMPROVEMENTS IN DRILLING

(71) We, NAGEL MASCHINEN-UND WERKZEUGFABRIK GMBH. a German Company, of Postfach 508, 744 Nurtingen, West Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

The invention relates to an apparatus and method for deep-drilling.

Deep-drilling was originally developed for drilling or re-drilling very long bores. However, it is also frequently used, nowadays, for shorter bores, since it enables bores of great accuracy and good surface quality to be produced in a single working operation. During deep-drilling, a coolant is fed through a coolant passage which is usually formed by a bore in the tool. Alternatively, however, it is possible to feed the coolant between the drill bit and the wall of the bore. However, the swarf is usually removed along this path, and for this purpose, the shank of the drill bit is provided with a V-shaped recess in the case of single-cutting edge deep drilling tools.

The bore is very heavily soiled by the machining operation and the coolant which is usually oleaginous. Therefore, it is necessary to clean the workpiece before it is further processed or before its measurements are checked. Since deep-drilling is a precision machining operation, the surface of the bore should on no account be damaged by adhering swarf when the drill bit is withdrawn.

According to one aspect of the invention, deep-drilling apparatus comprises a deep-drilling tool in which a coolant passage is defined, a coolant feed line, a compressed air feed line, and means for connecting the coolant passage to the coolant feed line during drilling and to the compressed air feed line at the end of a drilling operation for the purpose of introducing compressed air into the bore.

Another aspect of the invention is a method of drilling with the use of a deep-drilling tool having a coolant passage defined therein, in which coolant is passed through said passage during drilling and compressed air is passed through said passage after the completion of drilling.

Advantageously, after the supply of coolant has been shut off, compressed air is introduced into the coolant passage upon completion of the drilling operation, i.e. usually when the drill bit is still rotating or when it is slowing down. Thus, very intensive cleaning of the bore is achieved. The high rate of air flow not only immediately expels all the swarf, but also removes the coolant, so that a fully free and clean bore remains. There is also the advantage that the drill bit is also cleaned. As already mentioned, it is particularly advantageous for the compressed air to be blown out whilst the tool is still running, since all locations on the surface of the bore are then uniformly blown free from swarf, etc.

In the case of a blind bore, it is ensured from the outset that the entire length of the bore is blown out. However, the invention can also be used in the case of a through bore in a workpiece if the free end of the through bore is provided with a cover for the free end. When a through bore is referred to in this connection, it is meant to include both smooth and stepped bores which are drilled out by means of the deep-drilling tool, and also bores cut into the solid and which extend to the opposite end of the workpiece. The cover ensures that at least a portion of the compressed air is blown through the bore and does not flow out of the free end unused. The cover can either fully or partially close the bore end. It should at least have a considerable throttling effect on the compressed air, so that sufficient air can still flow back through the bore. In the case of through bores for example, in which the swarf is discharged directly out of the free end, the cover can be closed or mounted upon completion of the drilling operation. There are many conceivable possibilities of closing or mounting the cover,

such as automatically pressing-on the cover when the compressed air feed line is opened.

The supply of compressed air may be switched on manually or switched on automatically at the end of the drilling operation, for example by means of a time switch or limit switch and a solenoid valve. The compressed air is normally available in any workshop and can be taken from the compressed air supply system.

The invention is further described, by way of example, with reference to the accompanying drawing which is a diagrammatic longitudinal sectional view of deep-drilling apparatus in accordance with the invention.

The drawing shows deep-drilling apparatus having a deep-drilling tool 11 in the form of a single cutting edge drilling tool. The drilling tool has a cutting head 12 on the front end of which is a single cutting edge. The head has lateral guide and reaming portions. A coolant passage 13 in the form of a bore extends longitudinally through the tool and opens into the front end face 14 and has an inlet in the rear end face 15, i.e. the end face which faces the tool drive. The deep-drilling tool 11 has a coolant and swarf return conduit 16 in the form of a V-shaped groove which extends longitudinally over the greater portion of the deep-drilling tool. The deep-drilling tool is clamped in a clamping sleeve 17 which is rotatingly driven by means (not shown) and which can be advanced in an axial direction.

The apparatus also has a drilling bush 19 which guides the drill bit closely against the workpiece 18 and which is arranged in a drilling bush carrier 20. A co-rotating seal 21 ensures that the swarf and the coolant are diverted into a return chamber 22 in the carrier 20 and conducted into a swarf separation and coolant recovery system 23 (illustrated diagrammatically).

During operation of the deep-drilling tool 11 in the bore 24, coolant, which also has to flush away the swarf, is continuously fed by a pump 25 *via* a coolant feed line containing a valve 26 to a coolant inlet 27 in the clamping sleeve 17 from where it flows to the working region by way of the coolant passage 13 and is discharged by way of the return conduit 16.

However, a further line 28 is connected to the valve coolant inlet 27 and thus to the coolant passage. A valve 29 is located in the line 28. The line is connected to a source of compressed air, such as a compressed air supply system 30. The valves 26 and 29 may be solenoid valves and may, for example, be combined to form a single multi-position valve.

When, as is illustrated in the darwings, a blind bore is to be drilled, the tool advance is stopped after the required depth has been attained and the valve 26 is closed, with a certain time delay if required, so that the supply of coolant is terminated. The valve 29 is then opened, and compressed air from the supply system 30 flows through the coolant passage 13 and the return groove 16. The necessary precautions are taken at the recovery system 23 to ensure that the air, separated from any oil mist and swarf, can escape. Advantageously, the drill is still rotating during this action. Thus, the bore is blown out from all sides, and the drill bit can now be retracted and leaves behind a completely clean bore.

When through bores are being drilled, or through bores already exist which have only to be re-drilled, a cover 32 can be provided at the free end 31 of the through bore which is shown by broken lines in the drawings. In the present instance, the cover is diagrammatically illustrated in the form of a cap which can be pressed against the work piece in any optional manner or which may be secured thereto. It should, in any event, leave room for the tool 11 to break through and provide any sealing for the bore or, as already described before, provide a throttling effect, so that the compressed air blown through the coolant passage 13 is returned through the return passage 16 and blows out the bore.

However, a different method is possible in which, in a through bore without the cover 32, the compressed air remains switched on even during retraction of the tool from the bore 24. Thus, it is also possible to blow out the bore in a single working operation with the deep-drilling operation. In this case, of course, the bore is not cleaned before the tool 11 is retracted.

The invention has been described above with reference to a single cutting edge deep-drilling tool with a single coolant passage and an apparatus adapted thereto. However, the invention may be used with all types of single and multiple cutting edge deep-drilling tools or apparatus having various arrangements of coolant passages.

WHAT WE CLAIM IS:–

1. Deep-drilling apparatus comprising a deep-drilling tool in which a coolant passage is defined, a coolant feed line, a compressed air feed line, and means for connecting the coolant passage to the coolant feed line during drilling and to the compressed air feed line at the end of a drilling operation for the purpose of introducing compressed air into the bore.

2. Apparatus as claimed in Claim 1, in which a cover is provided for covering the free end of a through bore in the workpiece.

3. Apparatus as claimed in Claim 1, in which the connecting means includes a valve in the compressed air feed line to be opened during retraction of the deep-drilling tool.

4. Apparatus as claimed in Claim 1 or 2 in which the connecting means include a valve in the compressed air feed line to be opened while the deep-drilling tool is still rotating.

5. Apparatus as claimed in any of Claims 1 to 4 in which the coolant passage includes at least one return groove along the side of the tool.

6. Deep-drilling apparatus constructed and adapted to be operated substantially as herein described with reference to and as illustrated in the accompanying drawing.

7. A method of drilling with the use of a deep-drilling tool having a coolant passage defined therein, in which coolant is passed through said passage during drilling and compressed air is passed through said passage after the completion of drilling.

8. A method as claimed in Claim 7 in which the tool is rotated during tool retraction.

9. A method as claimed in Claim 7 or 8 in which said compressed air is passed through said passage during tool retraction.

10. A method as claimed in Claim 7, 8 or 9 in which the coolant passage includes at least one return groove along the side of the tool to enable the compressed air to wipe the wall of the bore clean.

11. Drilling methods substantially as herein described with reference to the accompanying drawing.

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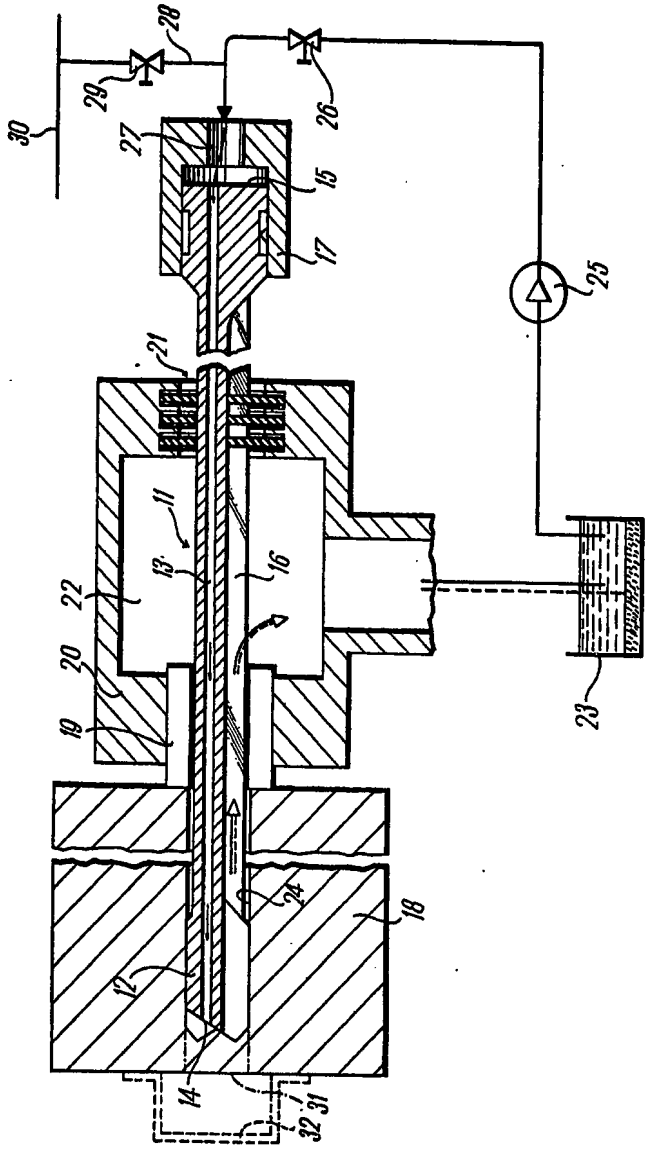
1 SHEET This drawing is a reproduction of the Original on a reduced scale



Mobile precision boring tool

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Abstract of **EP0838304**

The mobile drilling apparatus includes both a rotary drive (15) and a separate forward thrust drive (25) for the tool spindle (1). A measurement system (24) is provided for detecting the path of the forward thrust. The forward thrust drive is controlled by a computer in dependence on the axial forward thrust path so that the tool spindle is driven by the rotary drive with a predefined load speed or with a predefined load moment. The lubricant supply is controlled in dependence on the predefined load speed or the predefined load moment.

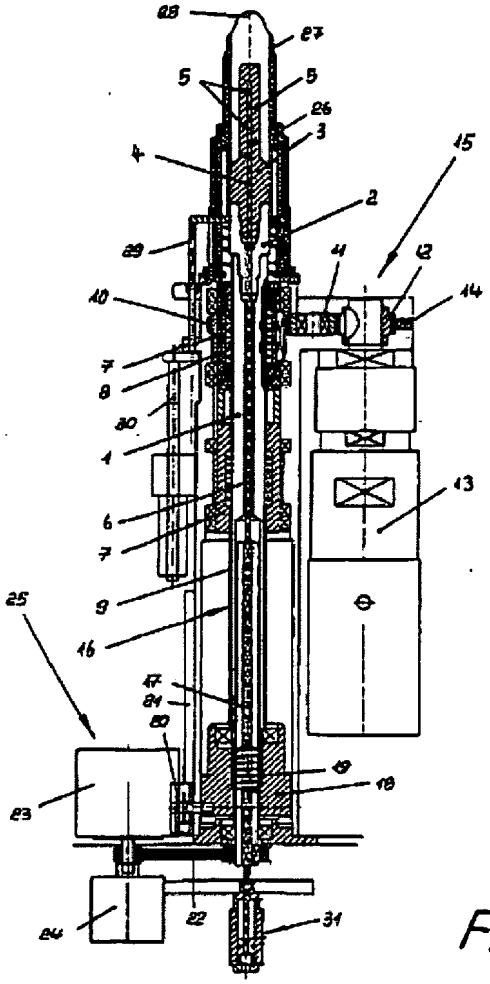

Fig.1